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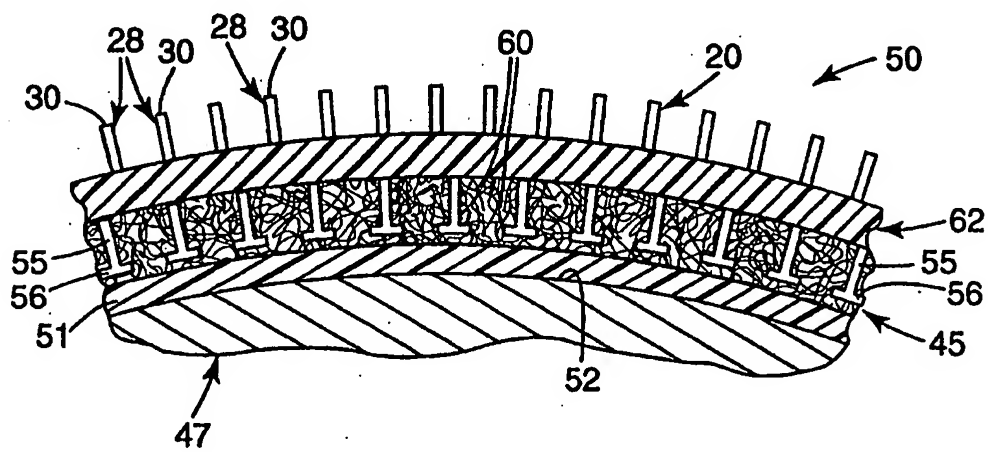

(57) Abstract

A textile pull roll cover (20) is disclosed which has a plurality of surface stems (28) projecting outwardly from one side thereof. The surface stems (28) are uniformly shaped and disposed on the pull roll cover (20), and the surface stems (28) collectively define an operative contact surface for a textile web. A plurality of hooking stems (55) project from an opposite side of the pull roll cover (20). The hooking stems (55) are adapted to releasably affix the pull roll cover (20) to a cylindrical pull roll (47) having loop structure material (45) adhered thereto. A method for making a textile pull roll (47) is disclosed, as well as a method for changing the outer textile engaging surface of a textile pull roll (47) using the hoop-and-loop opposed fastening arrangement, with the loop material (45) being disposed on the outer cylindrical surface (52) of the pull roll (47). The surface stems (28) and the hooking stems (55) are both integrally moulded with a surface substrate sheet (62).

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READILY REPLACEABLE ROLL COVERS

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for selective engagement with an advancing web. In particular, the invention relates most specifically to apparatus and methods for the assembly and ready replacement of covers for rolls used to engage advancing webs.

It is well known to provide a cylindrical roll with specifically desired frictional characteristics on its exterior surface for use in web advancement and treatment processes. In the textile industry, the use of rolls to convey, pull and hold back fabric is very common, and these rolls are referred to as pull rolls. For instance, weaving machines, inspection machines, finishing lines, napping lines, sueding lines and dye lines all contain numerous pull rolls to aid in performing such operations. Steel or aluminum rolls themselves do not provide surfaces with sufficient frictional forces to keep fabric from slipping in most applications. Such rolls are thus covered or coated with a material which aids in gently guiding the fabric through the textile processing machinery without distorting its weave, yet keeping the fabric relatively uniform in advancement and spread.

The cover on a pull roll may have a low or high coefficient of friction, depending upon the particular fabric, process characteristics and desired engagement or traverse of the pull roll with the fabric. Numerous materials have been used to define the frictional interaction between the roll surface and the fabric. Typical prior art pull roll cover materials include cork, rubber, modified cork, smooth rubber, sandpaper and bristle-bearing materials. During use of such materials, their frictional characteristics can change. For instance, cork and rubber-based materials tend to glaze over as they wear and become smoother, presenting a change in friction level to the fabric web over time. This can result in a slow deterioration of fabric quality or increased motor power usage due to slipping, which are both difficult to detect. In addition, abrasives such as sandpaper do not wear evenly, because of their random surface textures. Further, while abrasives such as sandpaper present higher frictional

characteristics for a pull roll cover, they are non-uniform by design and thus are unsuitable for some fabric webs because their non-uniformity results in damage to the fabric. Pull roll covers based on a bristled structure (such as the BRUSHLON™ brush material of Minnesota Mining and Manufacturing Company, St. Paul, Minnesota), are also random in bristle dispersion and alignment.

A pull roll cover material is typically applied by helically wrapping a two to three inch wide strip of the material down the length of the roll. Adhesion of the material to the roll surface has been accomplished by the use of contact cements, spray adhesives, and nonrepositionable pressure sensitive adhesives. To remove such roll covers from a roll requires removal of the roll from the textile processing machinery, and in some instances the machining off of the covering. These types of adhesion arrangements typically lead to build-ups of adhesive on the roll surface over time, contain flammable solvents in the adhesive, require long cure times on the roll surface, and in many cases require the use of flammable solvents for roll clean-up. Environmental concerns and restrictions now prohibit the use of many of these adhesives in textile plants, thereby requiring the removal and application of roll surfaces by outside parties and at locations other than the textile processing facility.

One type of pull roll cover forms a cylindrical brush, as disclosed in Dupre U.S. Patent 4,627,127. In Dupre, a fabric strip containing bristles on an outer peripheral surface thereof is wrapped in a helix about a cylinder. The fabric strip is adhered to the cylinder by means of an adhesive such as polyurethane. Through use, the bristles wear down and the remaining covering must be replaced. To remove such a covering bonded to the cylinder by an adhesive requires the use of solvents. This can be messy, relatively time consuming (resulting in machine downtime) and, as mentioned above, the use of solvents to remove adhesives creates undesirable hazardous waste removal issues. In an effort to address these environmental concerns, and also to form a more readily replaceable pull roll cover, mechanical fastening schemes (such as hook-and-loop fastener structures) have been used instead of adhesives to bond the cover material to the roll. One roll cover material currently available for this purpose has 1/8" trim nylon 6.12 bristle BRUSHLON™ brush

material (available from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota) on one side of a support substrate, with a loop structure material on its other side. A hook structure material (having projecting hooks or capped stems thereon) is bonded to the exterior surface of the cylindrical roll, typically in strip form wrapped thereabout in a helix. The bristle/loop structure assembly is also wrapped in strip form in a helix about the cylindrical roll, with the loop structure interengaging with the hook structure to affix the bristle/loop structure assembly to the pull roll cylinder. While this arrangement allows for ready removal of the exterior bristle bearing fabric, and replacement thereof with an alternative roll exterior material having a loop structure backing, it also is not ideal. The combination of the bristles, support substrate and hook-and-loop fastener form a pull roll cover assembly having a relatively high profile. Further, if the pull roll cover material is wrapped in an imperfect helix along the roll, one or more hooks may be inadvertently exposed from the hook structure material mounted on the cylindrical roll. These exposed hooks can damage the fabric web being traversed by the roll by picking or tearing at fabric fibers, creasing the fabric, scuffing its surface or by causing some other similar surface phenomenon.

A typical textile pull roll will have a diameter in the range of 4-12 inches, but can be smaller or larger. A high profile (relatively thick) pull roll cover increases the effective diameter of a pull roll, and this effect is even more significant on a smaller diameter pull roll (e.g., a 1-3 inch diameter pull roll). It is an undesirable necessity that drive roll speeds be adjusted if a significant change in roll diameter results from the application of a roll cover, and thus a pull roll cover should be as thin as possible.

The pickup or transfer of particulates or fluids by a pull roll cover is also undesirable. A cover material is also unacceptable if it allows lint and fiber build-up thereon during use. In addition, in some applications the roll or fabric web will be wet. For example, a roll cover must not pick up and hold fabric dyes from the manufacturing process. Color changes are common and the transfer of dyes from one fabric lot to another is unacceptable.

In view of the disadvantages associated with the various pull roll cover schemes of the prior art, it is desirable to provide a pull roll that has a changeable exterior covering, wherein the covering is relatively inexpensive, reusable or replaceable, easily and securely attachable to the cylindrical pull roll and which, in use, does not allow undesirable contact or damage to the web traversed thereby. Other desirable features in a replaceable pull roll cover are that the cover assembly have a relatively low profile, that it not collect lint or fibers, and that it not transfer dyes between webs. In addition, an exterior material for a pull roll cover is desired that has a long life, and provides the desired frictional characteristics, or range of frictional characteristics for customer flexibility.

SUMMARY OF THE INVENTION

In one embodiment, the present invention includes an engagement apparatus for selective engagement with an advancing web. The engagement apparatus includes a base having an outer surface with hook-engaging structures disposed thereon, and a surface substrate sheet having first and second major surfaces. The second surface of the substrate sheet has desired characteristics for frictional engagement with an advancing web. A plurality of hooking stems are provided on and project from the first surface of the substrate sheet. The hooking stems include means for hooking the hook-engaging surfaces on the outer surface of the base to releasably affix the surface substrate to the base.

In one embodiment, the second surface includes means for defining a frictional engagement surface for the advancing web. The defining means includes a plurality of surface stems projecting outwardly from the second surface of the surface substrate sheet, with the surface stems collectively defining an operative contact surface for contacting the advancing web. Preferably, the surface stems are disposed in a selected arrangement on and formed integrally with the second surface of the surface substrate sheet.

The present invention further includes a method of making a textile pull roll, which includes providing a base having an outer cylindrical surface, and providing a

substrate sheet having first and second major sides. The first side of the substrate sheet is releasably bonded to the outer cylindrical surface of the base. A plurality of surface stems are provided on and project outwardly from the second side of the substrate sheet, with the surface stems being formed integrally with the surface substrate and having outer ends which are generally uniform in height. The surface stems collectively define an operative textile contact surface for contacting a textile web. The bonding of the substrate sheet to the outer cylindrical surface of the base includes adhering the first side of the substrate sheet to the outer cylindrical surface by opposed hook-and-loop fasteners, with the loop fasteners being on the outer cylindrical surface of the textile pull roll.

The invention is further embodied in a method of changing the outer textile engaging surface of a textile pull roll. In this process, a pull roll is provided having a cylindrical pull roll base, a loop fastener structure secured to the pull roll base, and an initial substrate sheet releasably affixed to the loop fastener structure. The initial substrate sheet has first and second major sides, with the second side of the substrate sheet being defined by a textile engagement material and the first side thereof being defined by a hook fastener structure which is releasably engaged with the loop fastener structure on the pull roll base. The initial substrate sheet and textile engagement material thereon are removed from the pull roll base by disengaging the hook fastener structure on the initial substrate sheet from the loop fastener structure on the pull roll base. A replacement substrate sheet having first and second major sides is provided, with its second side being defined by a replacement textile engagement material and its first side being defined by a hook fastener structure. The replacement substrate sheet is affixed to the pull roll base by adhering the hook fastener structure thereon to the loop fastener structure on the pull roll base.

In any of the above embodiments, the first and second major surfaces of the surface substrate sheet can be laminated or integrally molded together. Additionally, in any of the above embodiments, including surface stems and hook fasteners, the surface substrate sheet, surface stems, and the hook fasteners can be integrally molded.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be further explained with reference to the drawing figures referenced below, wherein like structure is referred to by like numerals throughout the several views.

FIG. 1 is an isometric view of a textile web being advanced over a pull roll cover of the present invention.

FIG. 2A is a top plan view of the exterior pull roll cover of the present invention having upwardly projecting surface stems.

FIG. 2B is a sectional view as taken along lines 2B--2B in FIG. 2A.

FIG. 3 is a schematic illustration of an apparatus and process for forming the pull roll cover of FIGS. 2A and 2B.

FIG. 4 is a schematic view of a strip of loop fastener structure partially wound about the cylindrical base of a pull roll.

FIG. 5 is a schematic view of a strip of pull roll exterior cover material partially wound over the first strip and cylindrical base of a pull roll.

FIG. 6 is a sectional view as taken along lines 6-6 in FIG. 5.

FIG. 7 is a sectional view of an alternative pull roll cover assembly.

FIG. 8 is a sectional view of an alternative pull roll cover assembly.

FIG. 9 is a schematic illustration of an apparatus and process for forming an integrally molded pull roll cover.

FIG. 10 is a sectional view like FIG. 6 of an alternative pull roll cover assembly, made in accordance with the embodiment of FIG. 9.

FIG. 11 is a schematic illustration of an apparatus and process for forming the pull roll cover including an optional backing.

FIG. 12 is a sectional view like FIG. 6 of an alternative pull roll cover assembly, made in accordance with the embodiment of FIG. 11.

While the above-identified drawing figures set forth several preferred embodiments, other embodiments of the present invention are also contemplated, as

noted in the discussion. This disclosure presents illustrative embodiments of the present invention by way of representation and not limitation. Numerous other modifications and embodiments can be devised by those skilled in the art which fall within the scope and spirit of the principles of this invention. The drawing figures have not been drawn to scale as it has been necessary to enlarge certain portions for clarity.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a textile or fabric web 10 being processed along a web travel path which is defined, at least in part, by textile pull rolls such as pull rolls 12, 14 and 16. Such rolls may be driven or idler rollers, depending upon the processing application. The surfaces of the rolls are coated or covered with materials having the desired frictional characteristics for the application and for the fabric web being processed. The pull rolls are intended to keep the fabric web taut and uniformly disposed as it is processed. Depending upon the requirements for a specific pull roll, a high degree of friction may be required between the pull roll and fabric web to prevent slippage, or a low degree of friction may be required to allow a controlled degree of slippage of the fabric web over the pull roll.

FIGS. 2A and 2B illustrate the inventive pull roll cover material of the present invention. Functionally, the inventive pull roll cover 20 has a substrate 22 with a first side 24 adapted to be mounted onto a pull roll, and a second side 26 defining a frictional engagement surface for a fabric web which may be traversed or advanced over the pull roll. This engagement surface is further defined by a plurality of surface stems 28, which are disposed in a selected arrangement (it is preferred that this arrangement be a predetermined pattern) across the second surface 26, and are formed to have a generally uniform height projection from the substrate sheet 22. The selected arrangement for surface stem dispersal is preferably a uniform array, although any arrangement of surface stems is possible (including even a randomly designed dispersal of surface stems within a given area). In a preferred embodiment, the surface stems 28 are arrayed in staggered rows across the substrate 22, such as

row a, b, c, d in FIG. 2. Preferably, each surface stem 28 projects at a right angle relative to the second side 26 of the substrate 22, but alternatively angled stem orientations are also contemplated.

Preferably, the surface stems 28 and substrate 22 are formed integrally as a stem web, and the substrate requires no additional support layer or backing material. As shown, the surface stems 28 of the preferred embodiment are equally spaced apart and each is round in lateral cross section, having a generally uniform diameter along its height, from its outer end 30 to the second side 26. The surface stems 28 collectively serve to define an operative region or contact surface for the pull roll cover which contacts the advancing fabric web.

With a pull roll cover material 20 of this design (e.g., FIGS. 2A and 2B), the surface stems 28 provide a very uniform frictional engaging surface for presentation to the advancing fabric web, both initially, and as the surface stems 28 wear down during usage. The surface stems 28 wear uniformly, and since the diameter of the surface stems 28 is generally uniform along their height in the preferred embodiment, the surface area of stem ends 30 does not change because of changing stem structure along the entire height of the surface stems 28 as the surface stems 28 wear down. The inventive pull roll cover material thus presents a frictional engaging surface that is resistant to glazing and maintains a constant friction level during its useful life.

The use of uniformly disposed and formed surface stems as the engaging surface of a pull roll cover results in a highly controllable and predictable frictional engagement relationship between the pull roll cover and web. In addition to opposed roll and web material-to-material frictional interengagement characteristics, the precisely formed nature of the pull roll cover surface introduces a significant mechanical engagement component into the frictional engagement relationship. The upstanding surface stems on the pull roll cover penetrate interstices on the web surface (e.g., between the crossed fibers of its weave for a woven web) to engage the web mechanically. Testing suggests that such surface stems disposed on a pull roll cover do not damage many woven fabrics, as otherwise might be expected. Outer end portions of the surface stems actually engage the threads of a woven fabric web

to mechanically engage with the woven web as it is advanced past the pull roll. While such mechanical interengagement is a factor in the frictional relationship of prior art pull roll cover materials and woven webs (e.g., bristle based covers or abrasive material covers), those cover materials are not entirely uniform in the dispersement of their bristles or abrasive particles (as well as being less than fully uniform in terms of the size, height and diameter of their bristles or particles). As a result, the web engagement surfaces presented by those prior art cover materials to the web were not as uniform frictionally as desired. The uniformly shaped, sized and disposed surface stems of the present inventive pull roll cover present a homogeneous frictional surface for contacting the web. The surface stems of the inventive pull roll cover are particularly useful and effective in this regard when the web has a relatively uniform surface structure (e.g., woven or knitted), although the mechanical engagement characteristics are evident in relation to other web structures as well (e.g., spun bonded, nonwoven, etc.).

The inventive pull roll cover 20 illustrated in FIGS. 2A and 2B is resistant to the pickup of lint and fiber during use. Further, it is possible to use materials to fabricate the inventive pull roll cover 20 so that the cover 20 is resistant to dye pickup and transfer from the fabric web. In one embodiment, the inventive pull roll cover 20 is molded from Rexflex W108 available from Huntsman Chemical Company, Woodbury, New Jersey. Other possible materials for forming the pull roll cover 20 include Prevail™ 3050, available from Dow Chemical Company, Midland, Michigan, Himont KS084P, Montell-Himont, Atlanta, Georgia, and Hytrel™ 5526 or Surlyn™ 1702, both available from E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.

The nature of the inventive cover 20 is described by its combination of stem height, stem diameter, stem spacing and number of stems per square inch. The frictional characteristics of the cover 20 presented to the fabric web are altered by changing stem density, stem diameter, stem height or stem spacing, which in turn affect the surface area presented by the stem ends 30 of the surface stems 28 to the fabric web, and also affect the mechanical engagement relationship between the

weave of the fabric web and the surface stems 28 (e.g., a change in stem height may affect stem flexibility). Four examples of these parameters for the cover 20 are listed in Table I below:

TABLE I

Item	Stem Density	Substrate Thickness	Stem Height	Stem Diameter	Stem Spacing
A1	325 stems/in^2	0.005"	Approx. 0.037"	0.016"	0.055"
A2	325 stems/in^2	0.005"	Approx. 0.025"	0.015"	0.055"
A3	960 stems/in^2	0.004"	Approx. 0.006"	0.005" to 0.007"	0.032"
A4	2300 stems/in^2	0.003"	Approx. 0.006"	0.005" to 0.007"	0.021"

The stem spacing is the distance between centers of two adjacent stems. As shown in FIG. 2A, in a preferred embodiment the stems are uniformly spaced apart in all directions across the second surface 26 of the substrate 22.

The parameters listed in Table I are not meant to be limiting, and numerous variations in those parameters are possible for a particular cover. For instance, the stem density is preferably greater than 81 stems/in^2, and more preferably greater than 100 stems/in^2. Table I presents specific stem density examples of 325, 960 and 2300 stems/in^2, but stem web stem densities greater than 2300 stems/in^2 are also possible. Further, the surface stems may have a height gradient across the pull roll (e.g., shorter in center than near its ends) in order to facilitate web handling, the stems may not be round in cross-section, and the stem density and/or stem spacing may vary across the pull roll. In some applications, it may even be desirable that adjacent stems have different heights, or to have stems which change in profile (i.e., cross-section) along their height (e.g., a cylindrical stem having an enlarged, tapered stem base).

In the pull roll cover 20 just described, and the methods of making such pull roll cover materials described below, the cover material is typically formed by molding a flowable material. The flowable material can be any suitable material, such as a polymer, a metal or a ceramic precursor. It is also within the scope of this invention to use two or more different flowable materials to make the surface stems. The flowable material is a foamed or solid polymeric material (such as that described above), such as a thermoplastic material or a thermosetting material. Other suitable materials include thermoplastic polyurethanes, polyvinyl chlorides, polyamides, polyimides, polyolefins (e.g., polyethylene and polypropylene), polyesters (e.g., polyethylene terephthalate), polystyrenes, nylons, acetals, block polymers (e.g., polystyrene materials with elastomeric segments, available from Shell Chemical Company of Houston, Texas, under the designation Kraton™), polycarbonates, thermoplastic elastomers, and copolymers and blends thereof. The flowable material may also contain additives including but not limited to fillers, fibers, antistatic agents, lubricants, wetting agents, foaming agents, surfactants, pigments, dyes, coupling agents, plasticizers, suspending agents and the like.

FIG. 3 illustrates one embodiment of an apparatus and process for forming the inventive pull roll cover. This process generally involves molding surface stems in a substrate sheet from which the surface stems project. Substrate sheet 22 is formed, bearing a plurality of projecting surface stems 28 on one major surface thereof. The molding step may include any suitable molding apparatus, as known in the molding art. For example, the surface stems and substrate sheet could be injection molded, molded by compressing a heated sheet member against a molding surface, or molded by molding a flowable material over and into the cavities of a mold, which may be stationary or moving (e.g., a belt, a tape or a drum).

As illustrated schematically in FIG. 3, the process includes an extruder 35 adapted for extruding a flowable material, such as an impact copolymer resin, into a mold 37. The surface of the mold 37 includes a plurality of arranged cavities 39, which are adapted to form a like plurality of surface stems from the flowable material. The cavities 39 may be arranged, sized and shaped as required to form a

suitable surface stem structure from the flowable material. Typically, a sufficient additional quantity of flowable material is extruded onto the mold 37 to form substrate sheet 22 concurrently with the formation of surface stems 28. The mold 37 is rotatable and forms a nip, along with an opposed roll 41. The nip between the mold 37 and opposed roll 41 assists in forcing the flowable material into the cavities 39 of the mold 37, and provides a uniform substrate sheet 22. The temperature at which the foregoing process is carried out depends on the particular flowable material used. For example, the temperature is in the range of 140° to 260° C. for an impact copolymer resin available from Shell Chemical Company, Houston, Texas, under the designation SRD7-560.

The mold 37 may be of the type used for either continuous processing (such as a tape, a cylindrical drum or a belt), or batch processing (such as an injection mold), although the former is preferred. The cavities 39 of the mold 37 may be formed in any suitable manner, such as by drilling, machining, laser drilling, water jet machining, casting, etching, die punching, diamond turning and the like. The placement of the cavities 39 determines the spacing and orientation of the surface stems 28 on the substrate sheet 22, and thus on the inventive pull roll cover. The mold cavities 39 can be open at the end of the cavity opposite the surface from which the flowable material is applied to facilitate injection of the flowable material into the cavity. If the cavity is closed, a vacuum can be applied to the cavity so that the flowable material fills substantially the entire cavity. Alternatively, closed cavities can be longer than the lengths of the stems being formed so that the injected material can compress the air in the cavities. The mold cavities should be designed to facilitate release of the surface stems therefrom, and thus may include angled side walls, or a release coating (such as a Teflon™ material layer) on the cavity walls. The mold surface may also include a release coating thereon to facilitate release of the substrate sheet from the mold.

The mold can be made from suitable materials that are rigid or flexible. The mold components can be made of metal, steel, ceramic, polymeric materials (including both thermosetting and thermoplastic polymers) or combinations thereof.

The materials forming the mold must have sufficient integrity and durability to withstand the thermal energy associated with the particular molten metal or thermoplastic material used to form the substrate sheet and surface stems. In addition, the material forming the mold preferably allows for the cavities to be formed by various methods, is inexpensive, has a long service life, consistently produces material of acceptable quality, and allows for variations in processing parameters.

The flowable material is flowed into the mold cavity, and over the surface of the mold to form the substrate sheet. To facilitate flow of the material, the material typically must be heated to an appropriate temperature, and then coated into the cavities. This coating technique can be any conventional technique, such as calendar coating, cast coating, curtain coating, die coating, extrusion, gravure coating, knife coating, spray coating or the like.

After the thermoplastic material has been coated into the mold cavities and over the mold surface, the material is cooled to solidify and form the surface stems. The flowable material is solidified in and on the mold to form the surface stems and substrate sheet, which are then separated from the mold. The flowable material will often shrink when it is solidified, which facilitates release of the surface stem and substrate sheet from the mold. Part or all of the mold may be cooled to aid in solidifying the surface stems and substrate sheet. Cooling can be effected by the use of water, forced air, liquid nitrogen or other cooling processes.

When thermosetting resins are used as the flowable material, the resin is applied to the mold as a liquid in an uncured or unpolymerized state. After the resin has been coated onto the mold, it is polymerized or cured until the resin is solid. Generally, the polymerization process involves either a setting time, or exposure to an energy source, or both, to facilitate the polymerization. The energy source, if provided, can be heat or radiation energy such as an electron beam, ultraviolet light or visible light. After the resin is solidified, it is removed from the mold. In some instances, it may be desired to further polymerize or cure the thermosetting resin after the surface stem if removed from the mold. Examples of suitable thermosetting

resins include melamine, formaldehyde resins, acrylate resins, epoxy resins, urethane resins and the like. The formation of a substrate having upstanding stems on one side thereof is further detailed in pending U.S. Patent Application Serial Nos. 08/181,142; 08/181,193; and 08/181,195, all filed January 13, 1994.

The frictional characteristics of the inventive pull roll cover 20 have been established through both static and dynamic testing procedures. The dynamic friction was measured between a cloth and a selected pull roll cover surface by the following procedure. A pull roll cover was formed by helically wrapping a two-inch wide strip of the designated cover material on a five-inch diameter roll or core, providing a minimum of a four-inch wide covered surface for evaluation purposes. The five-inch core, end flanges and a one-inch shaft were mounted on a free wheeling supporting shaft. A two-inch wide strip of untreated jeans cloth (specifically, 96x64 jeans cloth, 1.943 yds/lb, Tencel™ fibers, available from Milliken Company, Spartanburg, South Carolina) was anchored at one end and placed over the designated pull roll cover material with approximately 180 degrees of wrap. A spring scale and wire were used to rotate the core and measure the amount of force (in ounces) necessary to move the pull roll cover material against the fixed cloth. The spring scale was a Chatillon scale, gauge R, Catalog No. 719-5 (0-5 lb. force gauge) (available from Chatillon, New York).

The results are tabulated in Table II below, and demonstrate the range of friction values provided by the various pull roll cover test materials. The values are in ounces of force required to produce smooth travel between the designated pull roll cover material and the two-inch wide strip of cloth.

TABLE II

Item	Pull Roll Cover Test Material	Measured Load (ounces)
B1	Scotch™ PTFE (Teflon™) Film Tape 5491 Extruded [1]	0
B2	Smooth Back of Stem Web (Stem Height approx. 0.030", Stem Dia. 0.015", Stem Spacing 0.050", Stem Density 325 stems/in², Substrate Thickness 0.005") [2]	0
B3	Safety-Walk™ Type 220 Fine Resilient Treads [1]	1
B4	Stem Side of Stem Web (same parameters as Item A2 from Table I) [3]	10
B5	Guilford 18904 Loop Cloth [4]	17
B6	Safety-Walk™ Type 370 Medium Resilient Treads [1]	48
B7	BRUSHLON® brush material, No. 331B 0.005" x 0.1875" Trim Type L 20° Tilt [1]	56
B8	BRUSHLON® brush material, No. 331B 0.003" x 0.125" Trim Type L 20° Tilt [1]	64

<u>Notes</u>

1. Available as identified from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.
2. The back side (no stems) of the inventive pull roll cover material formed from impact copolymer resin available from Shell Chemical Company, Houston, Texas, under the designation SRD7-560.
3. The front (surface stem) side of the inventive pull roll cover material formed from impact copolymer resin available from Shell Chemical Company, Houston, Texas, under the designation SRD7-560.
4. Available as identified from Guilford Mills, Inc., Greensboro, North Carolina.

The majority of these items were secured to the core using hook-and-loop mechanical attachment structures. The pull roll cover test material was laminated to a hook structure backing, with the hooks projecting oppositely from the frictional engaging surface of the pull roll cover test material. A corresponding loop structure was secured about the core for engagement with the loop structure backing on the

pull roll cover test materials. The hook structure in this example constituted either Velcro™ 811, Velcro™ 887 (both available from Velcro USA, Inc., Manchester, New Hampshire) or the polyolefin "mushroom" hook fastener portion of the 3M Mechanical Fastener Diaper Closure System (available from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota). The loop structure was Guilford 18904 loop cloth, available from Guilford Mills, Greensboro, North Carolina.

Since a pull roll cover is typically intended to prevent slippage of the fabric web and pull roll surface, a measurement of the static friction or the force required to create a slip between a fabric and a variety of pull roll cover test materials was performed. This analysis measured the horizontal force required to cause movement of a two-inch by four-inch surface of 14 oz. denim cloth against a pull roll cover material at two separate normal forces or weights on the two-inch by four-inch surface. The cloth was tested with its lighter colored (back) side facing the pull roll cover surface. The cloth was anchored to a metal block which was placed on top of a pull roll surface attached to a table top. The coefficient of friction was then calculated by dividing the horizontal force to cause slippage by the weight on the two-inch by four-inch surface area. The horizontal force was measured with a Chatillon force gauge Model DPP-50 (available from Chatillon, John & Sons, Inc., Greensboro, North Carolina). The measured horizontal forces and resultant coefficients of friction (COF) are presented in Table III below at both normal forces. Theoretically, the coefficient of friction is independent of surface area of contact and the normal force applied (for friction considered on a microscopic scale--i.e., a "smooth" surface against a "smooth" surface). In the present case, the frictional effect must be considered on a macroscopic sale (i.e., including the effect of the penetration of the stems into the weave of the web), so the expected independence of COF on surface area and normal force may not hold true.

Table III

Item	Pull Roll Cover Test Material	Horizontal Force (lbs), at Normal Force = 8.344 lbs	COF	Horizontal Force (lbs), at Normal Force = 26.358 lbs	COF
C1	Scotch™ PTFE Glass Cloth Tape 5453 [1]	1.6	0.19	4.8	0.18
C2	Smooth Back of Stem Web (back side of Item C7) [2]	3.3	0.40	9.6	0.37
C3	Guilford 18904 Loop Cloth [3]	3.7	0.44	9.0	0.34
C4	500 Impact Stripping Tape [1]	4.5	0.54	13.6	0.51
C5	Safety-Walk™ Type 220 Fine Resilient Treads [1]	4.5	0.54	13.8	0.52
C6	Safety-Walk™ Type 370 Medium Resilient Treads [1]	5.0	0.60	15.8	0.60
C7	Stem Side of Stem Web (Stem Height approx. 0.030", Stem Dia. 0.015", Stem Spacing 0.055", Stem Density 325 stems/in^2, Substrate Thickness 0.005") [4]	6.0	0.72	16.6	0.63
C8	Stem Side of Stem Web (Stem Height approx. 0.006", Stem Dia. approx. 0.006", Stem Spacing 0.032", Stem Density 960 stems/in^2, Substrate Thickness 0.004") [4]	6.1	0.74	18.6	0.71
C9	Scotch™ Polyurethane Protective Tape 8671 [1]	7.1	0.85	18.3	0.70
C10	216U Stikit™ Grade P320 Rolls [1]	7.4	0.88	20.4	0.77
C11	216U Stikit™ Grade P400 Rolls [1]	7.7	0.92	20.0	0.76
C12	216U Stikit™ Grade P180 Rolls [1]	7.8	0.94	21.1	0.80
C13	216U Stikit™ Grade P100 Rolls [1]	9.5	1.14	28.1	1.07

Notes

1. Available as identified from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.
2. The back (no stems) side of the inventive pull roll cover material, formed from impact copolymer resin available from Shell Chemical Company, Houston, Texas, under the designation SRD7-560.
3. Available as identified from Guilford Mills, Inc., Greensboro, North Carolina.
4. The front (surface stem) side of the inventive pull roll cover material, formed from impact copolymer resin available from Shell Chemical Company, Houston, Texas, under the designation SRD7-560.

The inventive pull roll cover (such as Items C7 and C8 in Table III) exhibits a particular frictional performance, as recognized by the above testing. That performance can be varied, not only by varying certain design parameters of the pull roll cover (e.g., stem height, diameter, density or spacing) but also by varying the material itself. Alternative materials for forming the pull roll cover have been mentioned above, and the frictional properties of those materials can be further altered by the use of additives (e.g., a filler) or coatings (e.g., a lubricious coating).

The significance of the mechanical interengagement component of the frictional characteristics of the inventive pull roll cover is illustrated by the results of further static friction testing in the manner detailed above. The horizontal force required to cause movement of a two-inch by four-inch surface of 14 oz. denim cloth or steel against a pull roll cover material at a normal force of 8.344 lbs. on a surface was measured. The cloth was tested with its lighter colored (back) side facing the pull roll cover surface. The cloth was anchored to a metal block which was placed on top of a pull roll surface attached to a table top. Items D1, D2 and D3 were tested on separate occasions for the cloth, hence the additional test data. The coefficient of friction was then calculated by dividing the horizontal force to cause slippage by the weight on the two-inch by four-inch surface area. The horizontal force was measured

with a Chatillon force gauge Model DPP-50 (available from Chatillon, John & Sons, Inc., Greensboro, North Carolina). The measured horizontal force and calculated coefficients of friction (COF) are presented in Table IV below.

TABLE IV

Item	Pull Roll Cover Test Material	Surface Material	Horizontal Force (lbs), at Normal Force = 8.344 lbs	COF
D1	Smooth Back of Stem Web (back side of Item D2)	Steel	1.77	0.2117
		Cloth - 1st	3.33	0.3994
		Cloth - 2nd	2.3	0.2756
D2	Stem Side of Stem Web (same parameters of Item A2 from Table I herein)	Steel	1.8	0.2157
		Cloth - 1st	6.03	0.7231
		Cloth - 2nd	6.07	0.7275
D3	Stem Side of Stem Web (same parameters of Item A3 from Table I herein)	Steel	1.9	0.2277
		Cloth - 1st	6.13	0.7351
		Cloth - 2nd	5.76	0.6903
D4	Stem Side of Stem Web (same parameters of Item A4 from Table I herein)	Steel	1.9	0.2277
		Cloth	6.03	0.7231

The pull roll cover test materials in Table IV are either the back side (Item D1 -no stems) of the inventive pull roll cover material, or its front side (Items D2, D3 or D4 - surface stems), and all were formed from an impact copolymer resin available from Shell Chemical Company, Houston, Texas, under the designation SRD7-560. The coefficient of friction for each of the different pull roll cover test materials in Table IV is much lower for the steel surface than the coefficients of friction for that same material in relationship to the cloth surfaces. The difference is believed to be the result of the mechanical interengagement of the surface stems and weave of the cloth, and its contribution to the frictional interrelationship between those two

materials. As can be seen by a comparison of the steel coefficients of friction and the cloth coefficients of friction in Table IV, this contribution is significant.

In addition to the inventive pull roll cover 20 itself, the present invention relates to the apparatus and method for use of a readily replaceable and repositionable pull roll cover. The invention allows relatively quick changeover from one cover to another on a pull roll by a simple and efficient arrangement that results in low machine downtime. In addition, the present invention does not require special handling or expertise (e.g., hazardous waste disposal) in the pull roll cover replacement process.

Previously, opposed hook-and-loop fastener structures have been used to secure pull roll covers to pull rolls. In all such instances, however, the hook structure material was mounted onto the pull roll. The pull roll cover then had loop structure material on its back side, and was helically wrapped about the pull roll with hook structure material mounted thereon. Occasionally, one or more hooks protruded (because of an imperfect helical wrap of the pull roll cover) from the pull roll exterior to contact the fabric web in use, picking and tearing at the fabric web as it traversed the pull roll cover. Any change to the surface of the cloth or its weave produced by the pull roll is considered to be damage to the cloth and is thus to be avoided.

The pull roll cover attachment of the present invention involves securing the loop material on the pull roll instead of the hook material. The loop material is bonded around the cylindrical outer surface of the pull roll. The loop material is preferably secured to the pull roll by a non-repositionable adhesive, since the loop material would rarely be removed or need replacement once secured onto the pull roll. The loop material, even if exposed by an imperfect spiral wrap of the pull roll cover over it, does not pick at the fabric traversing the pull roll, and thus significantly minimizes the possibility of damage to the fabric weave. The hook material used to secure the pull roll cover to the pull roll now projects away from the textile web, thereby preventing the possibility of picking or tearing the textile as it traverses the pull roll.

FIG. 4 illustrates the preferred method for the application of a strip of loop structure material 45 about the cylindrical outer surface of a pull roll 47. The loop structure material 45 is applied in a narrow strip (e.g., one to four inches wide) wrapped helically about a cylindrical outer surface 49 of the pull roll 47. The entire cylindrical outer surface 49 of the pull roll 47 (or at least that portion of the pull roll that contacts the textile web) is covered in this manner with the loop structure material 45. An adhesive (such as a pressure sensitive adhesive) is used to secure the loop material 45 to the pull roll 47.

The exterior pull roll cover material is bonded to a hook structure fastener material such that one major side of the pull roll cover (its inner side) has fastening hooks projecting therefrom while the other side (its outer side) has the desired frictional engaging surface projecting therefrom (for engaging and traversing a fabric web), thereby defining a pull roll cover assembly for application to the pull roll. The pull roll cover assembly is also preferably applied as a long narrow strip (e.g., one to four inches wide) which is helically wrapped around the pull roll. FIG. 5 illustrates the application of a strip of a pull roll cover assembly 50 about the pull roll 47. The pull roll cover assembly 50 is helically wrapped about the loop fastener structure 45, and can be oppositely wound relative to the winding of the loop fastener structure 45 (as illustrated in FIG. 5) if desired. The use of hook-and-loop fastening structures allows some slight axial or side to side play of the pull roll cover assembly 50 as it is being helically wrapped. This allows for the efficient achievement of fairly precise edge-to-edge wrapping, without the necessity for continued removal and repositioning of the pull roll cover assembly 50 to properly and completely cover the pull roll 47.

While a preferred embodiment includes the application of narrow strips of loop structure material 45 and pull roll cover assembly 50 in a helical wrap about the pull roll, other application configurations are possible. For instance, one or more longitudinally aligned strips may be adhered to the pull roll.

FIG. 6 illustrates, in more detail, the nature of the pull roll cover assembly 50 and its mounting to the pull roll 47 (which has a backing substrate sheet 51 of the

loop structure material 45 adhered to its cylindrical outer surface 52). The pull roll cover assembly 50 has its exterior side defined by the inventive pull roll cover 20. As such, the surface stems 28 of the cover 20 project outwardly from the substrate 22, with the outer ends 30 of the surface stems 28 defining the cylindrical textile engaging surface of the pull roll 47.

On its opposite side, the cover assembly 50 has means for hooking the loop structure material 45. In FIG. 6, the hooking means is illustrated as a sheet of hook structure material 53 having a supportive substrate 54 with an array of projecting hook stems 55 on one side thereof, with each stem having at least one head 56 thereon for interengagement with the looped and intermingled hook-engaging filaments of the loop structure material 45.

The opposed substrates 22 and 54 are bonded together to define the cover assembly 50 as a surface substrate sheet, with surface stems 28 projecting from one side and hook stems 55 projecting from its other side. A suitable adhesive for laminating the inventive pull roll cover 20 to the hook structure material 53 is Scotch® 9851 laminating adhesive, available from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota. An alternative adhesive is Scotch® 919 laminating adhesive, also available from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota. The particular laminating adhesive used depends upon the characteristics of the compositions used to form the pull roll cover 20 and hook structure material 53. In any event, the lamination is intended to be permanent and no separation of the facing substrates of the two materials, once bonded together, is desired. Webs of the pull roll cover 20 and hook structure material 53 (which may or may not be formed from the same material) are laminated by feeding those webs from rolls, removing and winding up any necessary adhesive liners, and bringing the laminating surfaces together in a rolling nip under controlled tension and pressure. The joined materials are then slit with a rolling knife and wound on cores to produce strip rolls of the pull roll cover assembly 50. The width of each pull roll cover assembly strip roll preferably ranges from one to four inches (and, more preferably, from two to three inches).

As mentioned above, in a preferred embodiment, the pull roll cover used with a particular pull roll should not be so thick as to significantly modify the effective diameter of the pull roll. Thus, in a preferred embodiment, a low profile hook-and-loop fastener structure assembly is desired so that the attachment means for the exterior pull roll cover surface is as thin as possible. The hook structure material 53 and the loop structure material 45 are thus mated in terms of their characteristics and structure to provide sufficient bonding strength but maintain a relatively low profile.

The loop structure material 45 can be either knitted loop, warp knitted loop fabric, stitched loop fabric, woven or nonwoven loop fabric. The loop structure material 45 presents intermingled fibers for engagement by the hooks 55 of the hook structure material 53. Preferably, the loop structure material 45 includes a plurality of loops 60 comprising filaments anchored to the loop structure substrate 54 at each end. The hook stems 55 thus become entangled in the loops 60 to attach the cover assembly 50 to the pull roll 47.

The loop structure material 45 should be such that it is easy, i.e., without much effort on the operator's part, to engage the hook stems 55 into the loop structure material 45. Likewise, when the cover assembly 50 is to be replaced, the operator should be able to easily remove the cover assembly 50 from the pull roll 47 by disengagement of the opposed hook-and-loop structure materials.

If the loop height is too high, it can lead to shifting of the cover assembly 50, which could lead to non-uniform contact with the advancing fabric web and scuffing or marring thereof. If the loop height is too low, there may be insufficient interengagement and attachment of the hook stems 55 and loops 60. In general, the height of the loops should be of the same order of magnitude as the height of the hook stems. Additionally, the loop dimensions and orientations may depend upon the shape and height of hook stems provided.

The loop density may also be selected to provide suitable performance characteristics. For example, the density of the loops can be the same as or different from the density of the hooks. If the loop density is too high, this increases the cost of the loop structure material, and it may be difficult to disengage the opposed hook

structure material. If the loop density is too low, there may be insufficient peel and shear strength to maintain the cover assembly 50 in place during use.

The loop structure material 45 includes a plurality of loops 60 comprising filaments which are intermingled together, as illustrated in FIG. 6. The filaments may either be individual filaments, or yarns comprising a group of twisted filaments. The filaments should be relatively strong to effectively hold the hook stem and not prematurely release the hook stem. Examples of such materials include inorganic fiber filaments, such as metal (including aluminum or steel), ceramic (including glass and fiberglass) and the like. The filament may also be a combination of different materials. The filament may be straight, curved or twisted, and may contain a surface treatment of some type, such as an antistatic coating, lubricious coating, etc. Examples of organic based filaments include both thermoplastic and thermosetting materials like polyamides, polyolefins, polyurethanes, aramides, polyester, cellulosic materials and the like. In general, it is preferred that the filament diameter be one-half the distance that the head 56 overhangs from the stem of the hook stem 55.

The loop structure material 45 can be bonded directly to the exterior surface of the cylindrical pull roll 47 (i.e., thermoplastic loops can be melt bonded thereto). Alternatively, a laminating adhesive can be used to secure the loop structure material to the pull roll. Examples of laminating adhesives include polyolefins, polyesters, polyurethanes, polyamides, hide glue, rubber based adhesives, urea-formaldehyde adhesives, epoxy adhesives, acrylate adhesives and the like.

A preferred loop material is Guilford 18904 loop cloth, available from Guilford Mills, Inc., Greensboro, North Carolina. This knitted loop cloth has a low profile (approximately 0.012 inch thick). A scrim has loop fibers on one side thereof, and is provided with an acrylic pressure-sensitive adhesive on its other side, which allows easy bonding of the loop cloth to the exterior cylindrical surface of the pull roll. A suitable adhesive for this purpose is A210 pressure sensitive adhesive film, available from illbruck, inc., Minneapolis, Minnesota.

The hook structure material 53 for the pull roll cover assembly 50 also has a relatively low profile, and preferably is formed from hook stem materials such as

those disclosed in Melbye et al. U.S. Patent 5,077,870 and in pending U.S. application Serial Nos. 08/181,142; 08/181,193; and 08/181,195, all filed January 13, 1994. One version of such material is the 3M Mechanical Fastener Diaper Closure System (available from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota). In a preferred embodiment, the hook structure material 53 is formed with the following characteristics: stem height = approximately 0.020 inches, stem diameter = 0.016 inches, head diameter = 0.030 inches, stem spacing = 0.055 inches, and stem density = 325 stems per inch^2. The hook stems 55 are formed integrally with substrate 54 (which is 4.5 to 5 mil thick), preferably of SRD7-560 impact copolymer resin, available from Shell Chemical Company, Houston, Texas.

Alternative hook structure material formations are also contemplated. As used herein, hook stem means a stem having a free end that is spaced from the surface to which the stem is attached and a structure that enables the hook stem to releasably hook the features of the engaging surface (loop structure material). In FIG. 6, each hook stem 55 is illustrated as having a head 56 shaped in the form of a nail head. Alternative hook stem and head configurations will function to suitably engage the loop structure material. For instance, the head may have any suitable three-dimensional shape, such as a hemisphere, sphere, mushroom cap, cube, pyramid, etc. Preferably, the head has at least one undercut portion that extends radially away from the stem at a right angle, such as the heads 56 shown in FIG. 6, to hook loop filaments of the loop structure material 45. Also, while the arrangement and formation of hook stems on the hook structure material 53 are illustrated as generally uniform, alternative stem patterns, such as non-uniform stems and stem array arrangements, will suffice.

A pull roll cover assembly, such as described above and illustrated in FIG. 6, combined with the preferred loop and hook materials described above, preferably has a thickness of less than 0.50 inch, more preferably less than 0.25 inch, and most preferably less than 0.09 inch, thus defining a relatively low profile covering for the pull roll. The low loft of the Guilford 18904 loop cloth was significant in its selection as a preferred loop structure material for this purpose.

The embodiment illustrated in FIG. 6 uses both the low profile pull roll cover 20 having upstanding surface stems 28, and the disclosed low profile pull roll cover attachment means. The pull roll cover assembly 50 is readily replaceable relative to the pull roll 47 bearing the loop structure material 45 on its exterior cylindrical surface 52. When a change in pull roll covers is desired, the pull roll cover assembly 50 can be removed by disengaging the hook stems 55 on the hook structure material 53 from the loops 60 of the loop structure material 45. A replacement pull roll cover assembly, having one side defined by a replacement textile engaging material and the other side defined by a suitable hook fastener structure, is then affixed to the pull roll by adhering the hook fastener structure thereon to the loop fastener structure on the pull roll. The replacement pull roll cover assembly is also typically applied as a thin strip, helically wrapped about the pull roll, as illustrated in FIG. 5. Replacement can be performed simply to replace a worn pull roll cover with another having the same frictional and mechanical engagement properties, or to replace a pull roll cover with another pull roll cover having different frictional and mechanical engagement properties. For instance, with respect to the inventive pull roll cover 20 illustrated in FIGS. 2A, 2B and 6, different frictional and mechanical engagement characteristics may be achieved by substituting a different pull roll cover of the same general structure, but having different surface stem densities, spacings, heights or diameters, or being formed from a different (i.e., less lubricious) material.

The use of the inventive hook-and-loop fastener arrangement of the present invention thus provides for a wide range of pull roll cover options for the same pull roll. The different pull roll cover materials can be readily replaced because of the ease and effectiveness of the inventive attachment arrangement where the loop structure material is essentially permanently attached to the pull roll, while the hook structure material is adhered or formed on the back of the pull roll cover. This is illustrated, for example, by FIG. 7, wherein a pull roll cover assembly 150 has a pull roll cover 120 formed from an alternative material. This could include any of the types of pull roll cover materials mentioned herein, such as cork, rubber, sandpaper, bristle brushes, films, cloths, Teflon™ substrates, polymeric coatings, polymeric

coatings containing additives, coated abrasives, nonwoven abrasives, smooth or textured polymeric films, glass coatings, paper, foam, nonwoven materials, metal foils, and other materials, such as those listed in Tables II and III. Another pull roll cover material is a microreplicated surface, such as a structural abrasive article, available under the trade designation 207EA structured abrasive article, from Minnesota Mining and Manufacturing Company, St. Paul, Minnesota. The possible pull roll cover materials are limited only by the desired frictional characteristics of such materials, and their suitability for use in a particular textile pull roll application. The alternative pull roll cover assembly 150 has a cover 120 with an exterior textile engaging surface on one side, and on its opposite side, it bears a hook structure material or structure such as hook structure material 153. This hook structure material 153 in turn is releasably engageable with loop structure material 145, which is bonded to cylindrical outer surface 152 of pull roll 147. The cover assembly 150 can thus be removed for replacement or change with another pull roll assembly having the same or different frictional engagement characteristics, as desired.

FIG. 8 illustrates yet another embodiment of a pull roll cover assembly 250. In this embodiment, no separate or discrete exterior pull roll cover is provided. The exterior (pull roll) surface of the pull roll assembly 250 is defined by the side or surface 251 of hook structure material 253 opposite its hook stems 255. The hook structure material 253 is again releasably engageable with loop structure material 245 adhesively bonded to cylindrical outer surface 252 of pull roll 247. The exterior surface 251 of hook structure material 253 itself serves as the textile engagement surface of the pull roll cover. The frictional characteristics for two versions of this type of pull roll cover assembly are listed in Table II (Item B2), Table III (Item C2), and Table IV (Item D1).

FIG. 9 illustrates an alternative method of molding the inventive pull roll cover. As illustrated schematically in FIG. 9, the process includes an extruder 35 adapted for extruding a flowable material, into molds 37 and 41a. The surface of mold 37 includes a plurality of arranged cavities 39, which are adapted to integrally mold a like plurality of surface stems from the flowable material. The surface of

mold 41a includes a plurality of arranged cavities 39a, which are adapted to integrally mold a like plurality of hooking stems 55 from the flowable material. Typically, a sufficient additional quantity of flowable material is extruded onto molds 37 and 41a to integrally mold a uniform substrate sheet 62 concurrently with the formation of surface stems 28 and hooking stems 55. Molds 37 and 41a are rotatable and form a nip. The nip between the mold 37 and opposed mold 41a assists in forcing the flowable material into the cavities 39 of mold 37 and the cavities 39a of mold 41a, and provides an integrally molded substrate sheet 62 including hooking stems 55 and surface stems 28. The surface stems 28 and hooking stems 55 may be lined up with one another or may be offset from one another and may have either the same or different pattern, arrangement or density. Either the top or middle roller could make the hooking stems or surface stems. Heads are formed on the hooking stems 55 by heating and compressing the tops of the stems with a heated roller 64. There is a nip between heated roller 64 and cool roller 66. The height of the nip is set to get the desired height of the hooking stems 55. It is also possible to form the head incrementally by passing the surface substrate sheet through a series of progressively smaller nips.

FIG. 10 illustrates, in more detail, the inventive pull roll cover assembly molded by the method shown in FIG. 9, showing integrally molded sheet 62. The integrally molded sheet 62 defines the cover assembly 50 as a surface substrate sheet, with surface stems 28 projecting from one side and hook stems 55 projecting from its other side. All methods and materials described above for laminated surface substrates are suitable for the integrally molded embodiment.

FIG. 11 illustrates an alternative method of integrally molding the inventive pull roll cover assembly with optional backing 66 within the integrally molded sheet 62. Any number of materials may be used as a backing depending on the polymer being used and final properties desired. The reasons for incorporating backing 66 include: reinforcing the material, eliminating stretch, improving tear resistance or improving adhesion of another layer.

FIG. 11 is similar to the manufacturing process illustrated in FIG. 9. However, backing 66 is fed between two extruders 35 which are adapted for extruding a flowable material into molds 37 and 41a. Common types of backing materials include: woven scrims, nonwoven scrims, spun bonded scrims, adhesive bonded scrims, papers, polymer films, and foils. Backing materials successfully incorporated include: 18 x 12 polyester warp/nylon weft, product number 924831-012-1966 and 18 x 18 polyester warp/nylon weft, product number 924831-018-1966, (both available from Milliken & Company, Spartaburg, SC) and polyester spun bond, Style 2214 and polyester spun bond, Style 2016 (both available from Reemay, Inc., Old Hickory, TN). The two extruders 35 can extrude two different polymers or the same polymer as desired, with or without backing 66.

FIG. 12 illustrates, in more detail, the inventive pull roll cover assembly molded by the method shown in FIG. 11, showing integrally molded sheet 62 including backing 66. The integrally molded sheet 62 defines the cover assembly 50 as a surface substrate sheet with backing 66 and with surface stems 28 projecting from one side and hook stems 55 projecting from its other side. All methods and materials described above for laminated surface substrates are suitable for the integrally molded embodiment.

EXAMPLES

Example 1

A patterned silicone mold 0.25" thick by 12" wide by 25.1" long was prepared by drilling the pattern of holes about 0.015" diameter and about 0.100" deep disposed in a staggered arrangement having a spacing of 0.055" by 0.055"

A chilled 2-roll stack was assembled with cylindrical rolls 12-inch wide x 8-inch diameter (30.5 cm x 20.3 cm). Each roll was covered with silicone molds described above by first covering the rolls with protective polyvinyl chloride tape, followed by spirally-wrapped double-sided laminating tape (acrylic adhesive on one side, silicone pressure-sensitive adhesive on the other). The acrylic adhesive faced toward the roll surface and the silicone pressure-sensitive adhesive faced

away from the roll surface. The silicone mold was then adhered to each roll on the silicone pressure-sensitive adhesive. Silicone molding compound was used to level and fill the butt splice for each adhered mold. A 12-inch wide (30.5 cm) molten sheet of "Catalloy KS 084P" (Montell Polyolefins, Wilmington, DE) flexible polypropylene was extruded at 310°F (154°C) from a sheet die mounted to a 1.75-inch (44.4 mm) HPM single-screw extruder operating at 60 r.p.m. A remote-sensing infrared temperature monitor was used to adjust the temperature of the die orifice to achieve uniform molded product. The molten sheet was introduced into the nip of the mold-covered rolls that were rotating at 7.5 feet per minute (2.3 meters per minute). As the molten sheet was solidified by the chilled roll surfaces, the top mold released the sheet to follow the bottom roll, and the molded product was subsequently stripped away from the bottom roll. Upon further inspection of the product, the projections on the top side were 0.021 inch (0.53 mm) in length, the projections on the bottom side were 0.027 inch (0.69 mm) in length, and the total product thickness was 0.062 inch (1.57 mm).

Example 2

Example 2 demonstrates the effectiveness of the present invention to make an industrial roll covering material having projections on both major surfaces, each being of a different composition. Such articles provide an improved friction surface with an integral attachment means. A molten polymeric film having two major surfaces was prepared by extruding through a split-manifold bicomponent film die fed by two single-screw extruders, both operating at 400 °F (204°C). The first major surface of the bicomponent film was of Shell polypropylene "SRD 7-560", now available from Union Carbide Corporation, Danbury, CT. The second major surface was of "Rexflex FP-D1720" flexiblized polypropylene, commercially available from Rexene Corporation, Dallas, Texas. The extruded bicomponent film was introduced into the nip between the top and middle roll of a vertical stack of three temperature-controlled co-rotating 5-inch diameter (12.70 cm) cylindrical rolls, the top and middle rolls having aluminum sleeves with

cylindrical cavities (.026 inch (0.66 mm) deep by 0.018 inch (0.46 mm) in diameter, and 0.052 inch (1.32 mm) deep by 0.018 inch (0.46 mm) in diameter, respectively) disposed in rows parallel to the rotational axis about the circumference of each roll, the cavities and rows both being spaced 0.0556 inch (1.41 mm) apart. Alternate rows of cavities were offset 0.0278 inch (0.71 mm) to produce a staggered array. The continuous, molten bicomponent film was deposited into the nip between the top and middle rolls, the mold was rotated approximately 180° to the nip between the middle and bottom rolls where the now partially-cooled bicomponent film was contacted by and transferred to the surface of the third roll, a chrome plated steel roll, and the third roll rotated another 180° where the molded bicomponent article was removed from the second mold surface by a tension-controlled winder. The projections thus formed on the first major surface were readily deformable into a mushroom-shaped cap upon contact with a hot surface to provide a mechanical fastening surface suitable for mating with a surface having a fibrous loop surface. The projections thus formed on the second major surface were tough and flexible, providing for durable engagement with a traversing web or sheet when employed as the contact surface of an industrial roll.

The inventive pull roll cover 20 of the present invention overcomes many of the disadvantages of the prior art. It provides a pull roll cover having initially uniform and extremely consistent frictional engagement characteristics, which includes controlled and non-abrasive mechanical engagement with a textile web traversed thereby. The inventive pull roll cover 20 has a low profile and maintains its engagement properties uniformly during wear of its surface stems. The pull roll cover surface stems do not pick or tear at a textile web, it is resistant to the transference of dye from one textile web lot to another, and it does not exhibit a buildup of lint and fibers during use. The inventive pull roll cover 20, when combined with the inventive hook-and-loop fastener means for attaching a pull roll cover to a pull roll (with the loop structure material bonded to the pull roll), results in a superior, low profile, inexpensive and easy to use pull roll cover replacement arrangement. The unique and inventive attachment arrangement eliminates the

possibility of damage or picking of the web by the attachment components themselves.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. For instance, the base structure for application of the invention has only been described with respect to cylindrical pull rolls. The inventive cover and the novel cover attachment method disclosed herein can be applied to other base structures, such as an endless belt or other surface which may come into contact with an advancing textile web in a textile processing or manufacturing facility. Further, the invention is also applicable in applications other than textile pull rolls. Any surface which contacts a web or sheet or other substrate workpiece is a candidate for the inventive cover and inventive cover attachment arrangement of the present invention. For instance, the roll cover can be applied to a one-inch diameter transfer roll in a photocopy machine. In this regard, possible web materials may include, but are not limited to, woven, nonwoven, knitted, needle tacked, wet laid, stitch bonded and spun bonded materials, as well as papers, films, foils, and metal sheets or strips.

WHAT IS CLAIMED IS:

1. An engagement apparatus for use on a textile pull roll having a cylindrical outer surface which traverses an advancing web, the engagement apparatus comprising:

a) a surface substrate sheet having first and second sides, the second side of the sheet having a plurality of surface stems projecting outwardly therefrom, the surface stems being disposed in a selected arrangement on and formed integrally with the surface substrate sheet, and the surface stems being generally uniform in height and collectively defining an operative web contact surface;

b) means for releasably securing the first side of the surface substrate sheet to the cylindrical outer surface of the roll;

c) wherein the securing means comprises opposed hook and loop fasteners on the first side of the surface substrate sheet and at least a portion of the cylindrical outer surface of the roll, with the loop fasteners being on the cylindrical outer surface of the roll and the hook fasteners being on the first side of the surface substrate sheet; and

d) wherein the surface substrate sheet, the surface stems, and the hook fasteners are integrally molded.

2. A engagement apparatus for selective engagement with an advancing web, the engagement apparatus comprising:

a) a base having an outer surface with hook-engaging structures disposed thereon;

b) a surface substrate sheet having first and second major surfaces, the second surface having desired characteristics for frictional engagement with an advancing web; and

c) a plurality of hooking stems provided on and projecting from the first surface, the hooking stems including means for hooking the hook-engaging structures on the outer surface of the base to releasably affix the surface substrate sheet to the base;

d) wherein the second surface of the surface substrate sheet has a plurality of surface stems projecting outwardly therefrom, the surface stems collectively defining an operative contact surface for the advancing web; and

e) wherein the surface substrate sheet, the surface stems, and the hook stems are integrally molded.

3. A surface cover assembly for releasable affixation to an opposed surface having hook-engaging structures, comprising:

a) a cover substrate having a first major surface, and an opposite second major surface;

b) a plurality of surface stems disposed in a selected arrangement to project outwardly from the second major surface of the cover substrate, the surface stems collectively defining an operative contact surface for the surface cover assembly;

c) a plurality of hook projections extending outwardly from the first major surface of the cover substrate, wherein the hook projections each include means for hooking the hook-engaging structures to releasably affix the surface cover assembly to the opposed surface; and

d) wherein the cover substrate, surface stems, and hook projections are integrally molded.

4. An engagement apparatus for use on a textile pull roll having a cylindrical outer surface, the engagement apparatus comprising:

a loop structure material bonded to the cylindrical outer surface of the pull roll, the loop structure material having a plurality of projecting loops; and

a surface substrate formed from a integrally molded composite including:

a surface substrate sheet having first and second sides, the first side of the sheet having a plurality of surface stems disposed in a selected arrangement to project outwardly therefrom, with the surface stems collectively defining an operative textile engaging surface, the second side of the sheet having a plurality of hooking stems projecting outwardly therefrom, and the hooking stems including means for hooking the projecting loops on the loop structure material to releasably affix the surface substrate to the pull roll, wherein the surface substrate sheet, the hooking stems, and the surface stems are integrally molded.

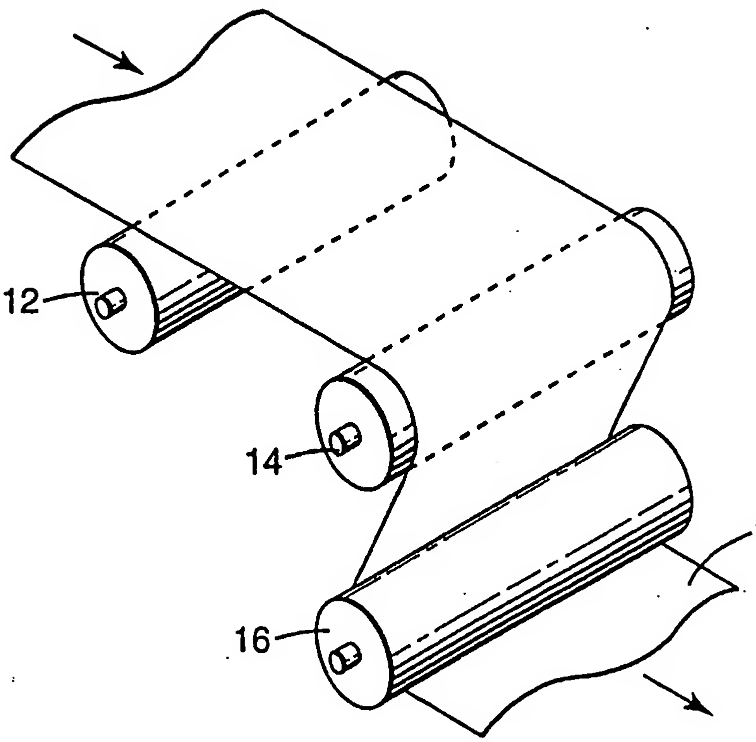


Fig. 1

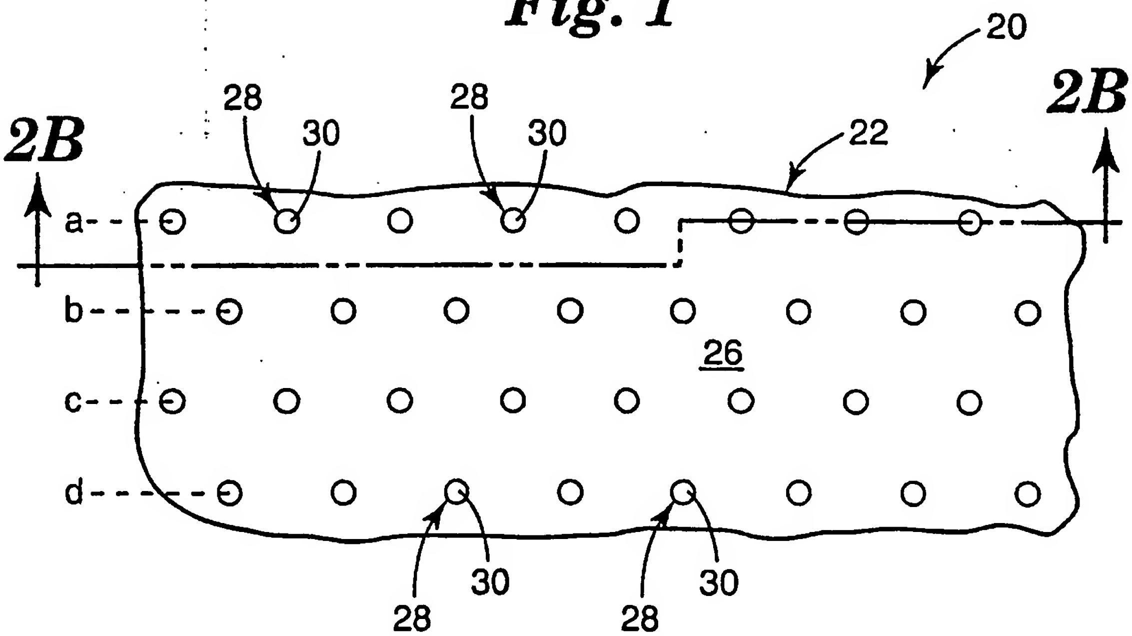


Fig. 2A

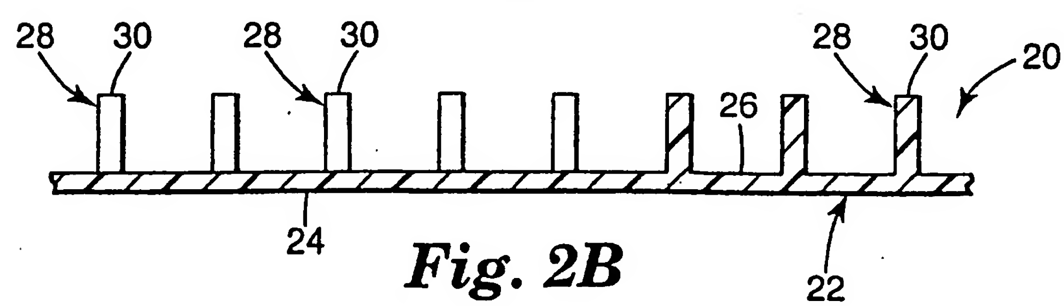
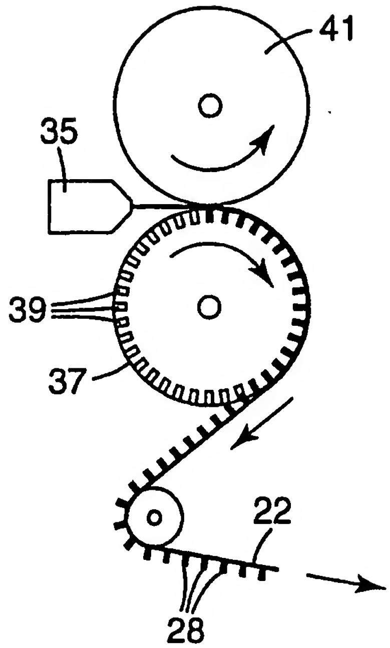


Fig. 2B



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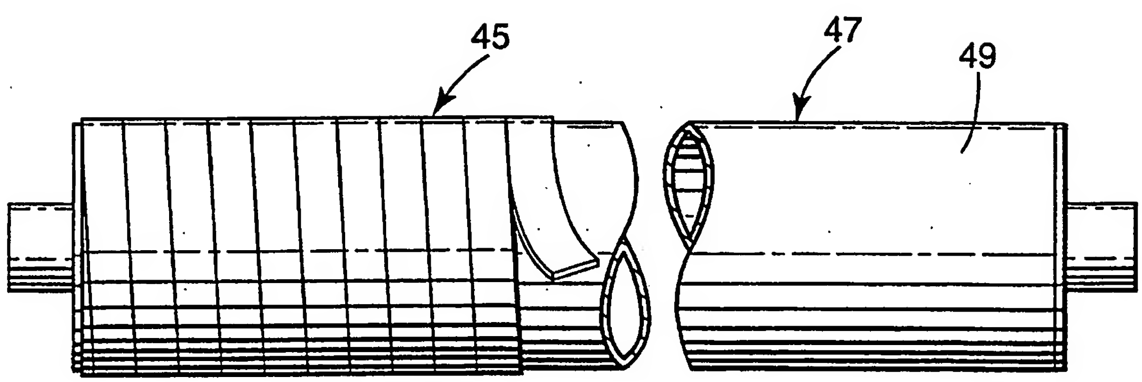

Fig. 4

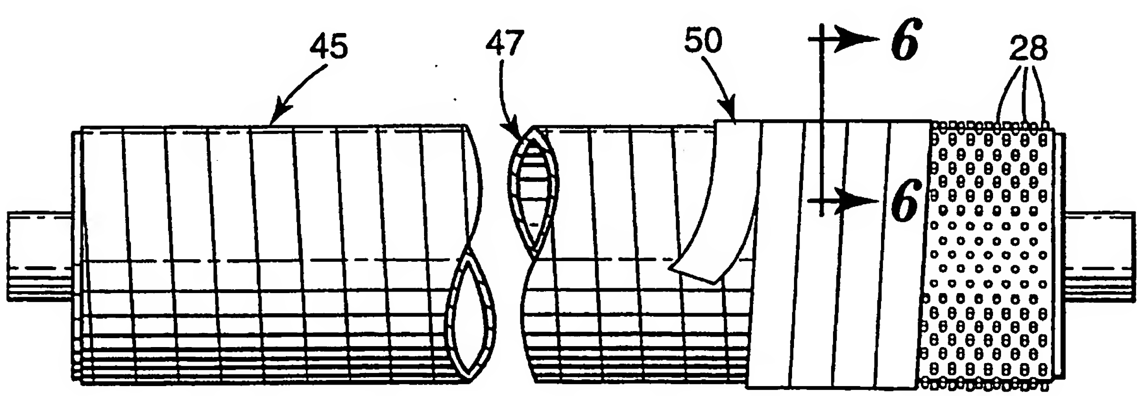

Fig. 5

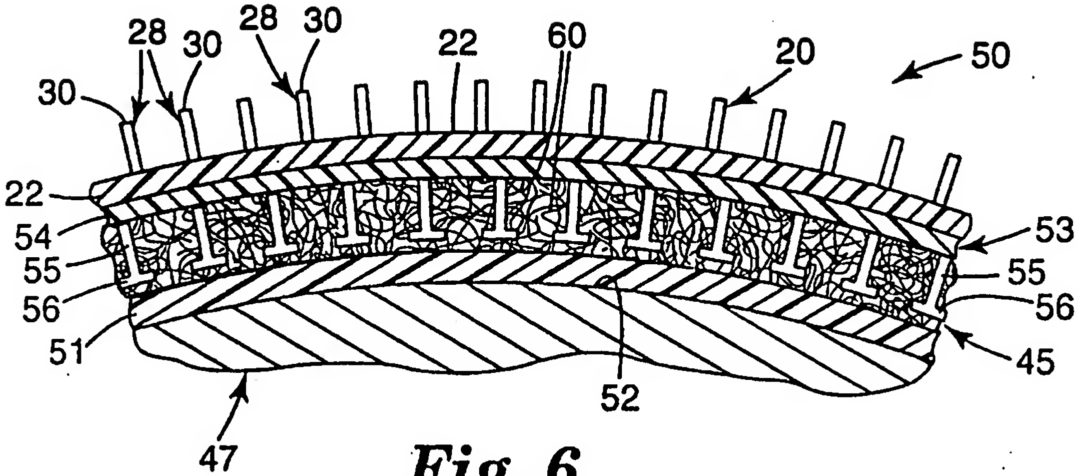

Fig. 6

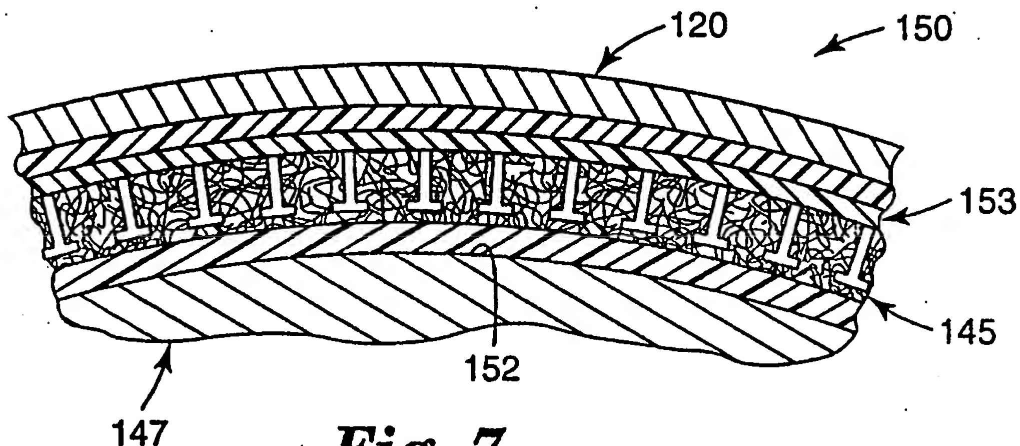

Fig. 7

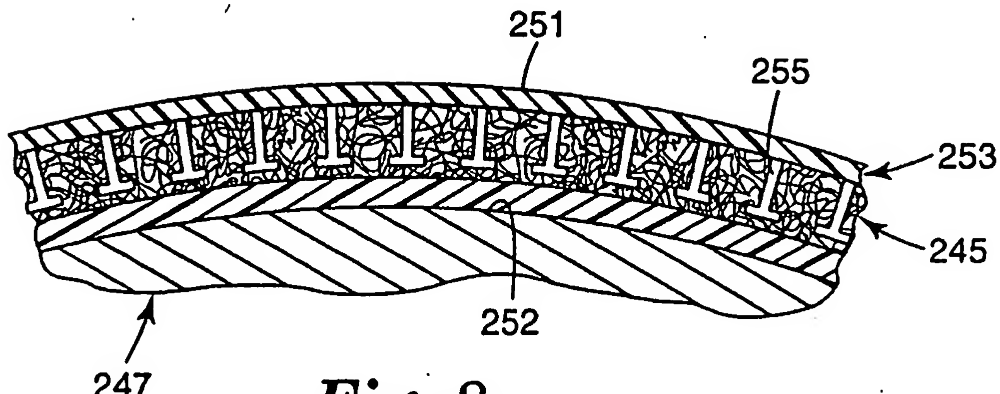

Fig. 8

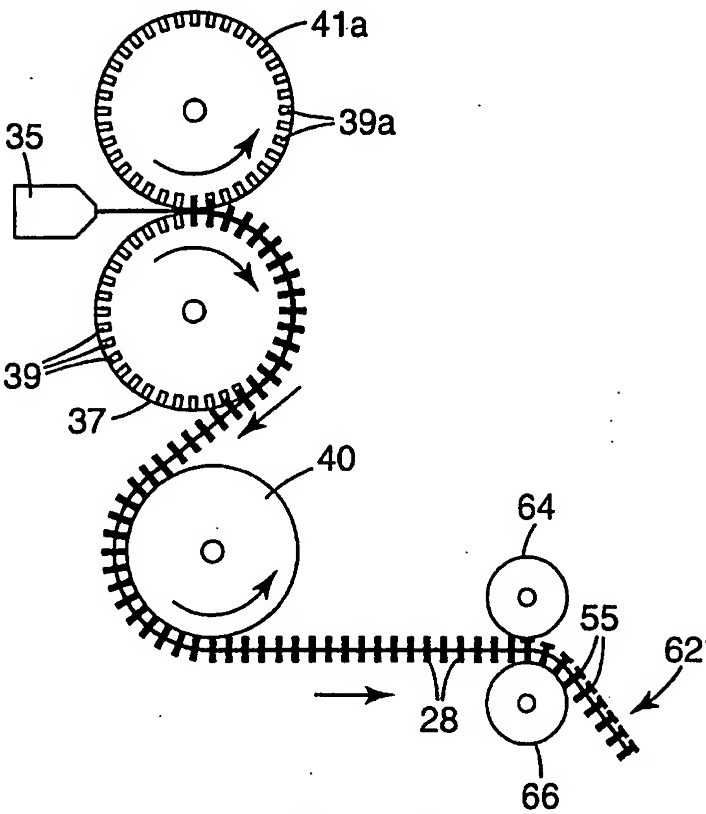
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Fig. 9

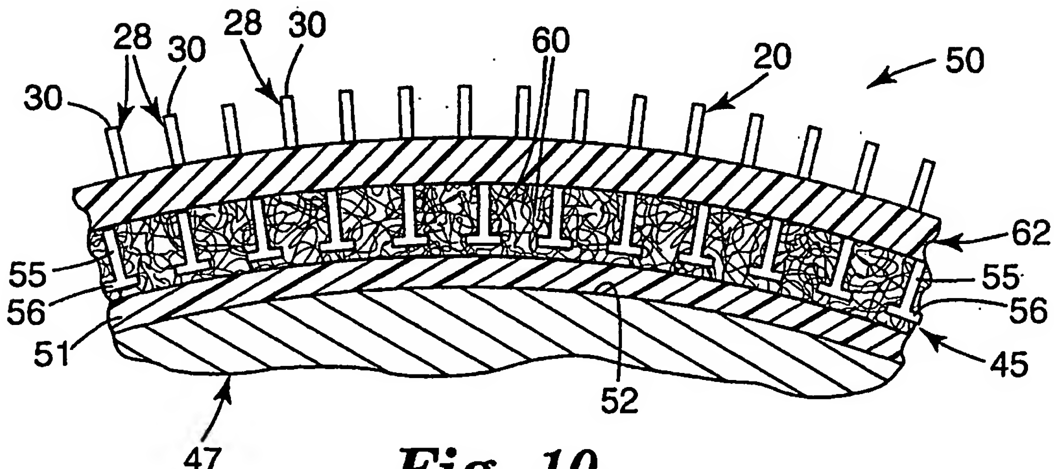
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Fig. 10

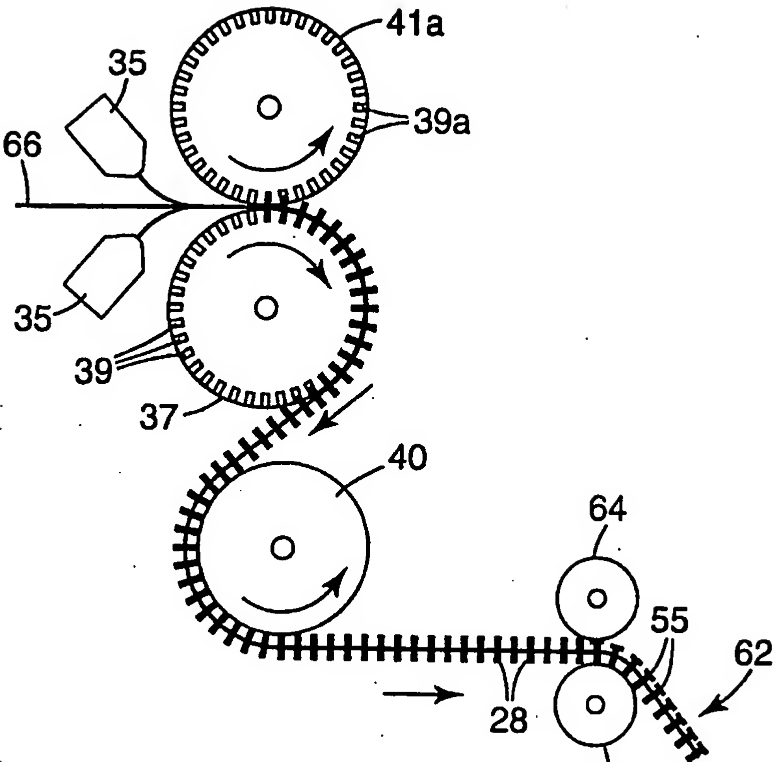
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Fig. 11

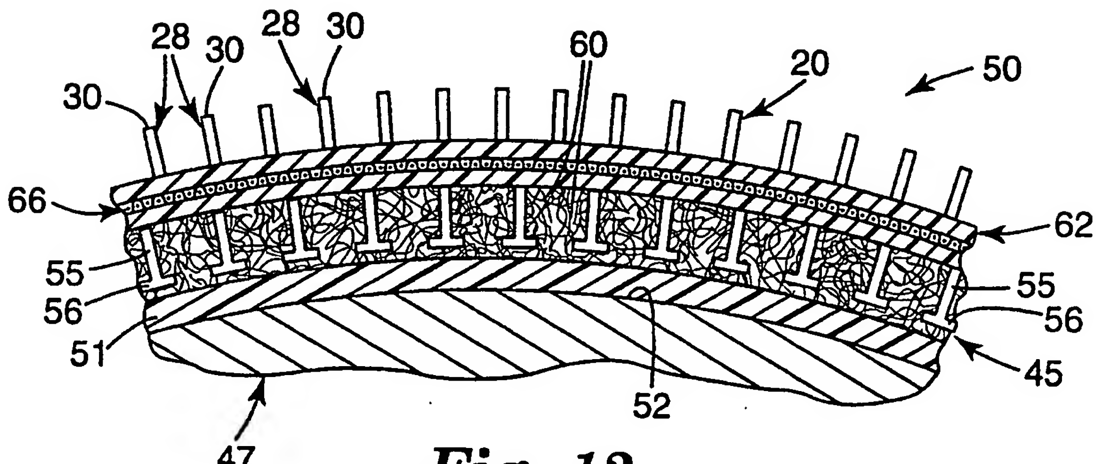
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Fig. 12

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/03047

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B65H27/00 D06B23/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D06B B65H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 97 32805 A (MINNESOTA MINING AND MANUFACTURING COMPANY) 12 September 1997 see claims 1,2,7,12,21,27-29; figures 1-6 -----	1-4

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 May 1998	19/06/1998

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INTERNATIONAL SEARCH REPORT

Information on patent family members

In. .tional Application No
PCT/US 98/03047

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9732805 A	12-09-1997	AU 2116297 A	22-09-1997